Crimson Publishers
Wings to the Research

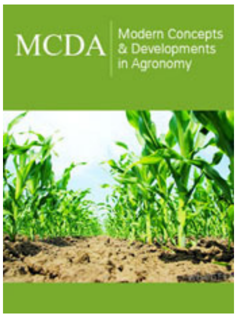
Mini Review

How Much Humus Does the Arable Land Need?

Martin Körschens*

Förderverband Humus e. V., Lauchagrund 1, Goethestadt Bad Lauchstädt, Germany

ISSN: 2637-7659



***Corresponding author:** Martin Körschens, Förderverband Humus e. V., Lauchagrund 1, Goethestadt Bad Lauchstädt, Germany

Submission: March 24, 2023
Published: April 12, 2023

Volume 12 - Issue 5

How to cite this article: Martin Körschens. How Much Humus Does the Arable Land Need?. Mod Concep Dev Agrono. 12(5). MCDA. 000796. 2023.
DOI: 10.31031/MCDA.2023.12.000796

Abstract

For the evaluation/assessment of the C_{org} content of arable land, only the nutrient humus C is of importance. On average, this is 0.3% C_{org} and is below 0.2% in more than 40%. The difference between "good" and "bad" is often within the error limit. The C_{org} content of long-standing bare fallow land has proven to be a suitable criterion for permanent humus. The levels of total humus C in Long-Term Field Experiments (LTE) are between 0.22% C_{org} and 4.17 % C_{org}. In about 40% of the experiments, the C_{org} content of the optimally organically and minerally fertilized variants is less than 1% C_{org} (=1.724% humus). The humus balancing method [1] is the only way to assess the humus supply status of the soil. It urgently needs to be revised after 50 years. The mineral fertilization ensures the nutrition of the people through the high yields and is also the basis of an adequate supply of humus. Long-term field experiments are an indispensable experimental prerequisite for practice-oriented humus research.

Introduction

We live from what the soil gives us. Soil is formed over centuries. Humus is a prerequisite for soil formation. It makes the difference between the soil and the starting substrate. (Humus = Soil Organic Matter (SOM) = organic carbon (C_{org}) x 1.724) = living and dead organic matter integrated in the soil "[2].

Carbon and nitrogen are the most important soil-forming properties. In contrast to almost all other soil properties and pollutants, there are no standard or orientation values for humus. Only the humus balancing method [1] is the only way to estimate the humus supply status of the soil. This situation is extremely unsatisfactory and inevitably leads to completely unrealistic ideas and irritations. It offers space for speculation and criminal trading in CO_2 certificates. In recent years, humus has often been seen as a "climate saver" and CO_2 has become a lucrative trade item [2]. In this regard, great nonsense is spread not only by laypeople, but especially by the media. Here are just three examples: "If we make the soils better" –for example. by Terra Preta - "then easily 30 billion people can live on earth, everyone can be fine, that can also be done without any problems" (documentary film, 2009).

"In Austria and Germany, we only have 4kg of carbon per m^2 of arable land bound in the humus, it used to be at least 30kg. Our farmland falls under the category of desert.... Only 8kg of carbon per m^2 more is bound in the agricultural humus layers and the CO_2 content of the atmosphere is again below the critical value of 300ppm [3]. "A global increase in humus of just one percentage point could remove 500 gigatonnes of CO_2 from the air"[4].

But science and politics also make a massive contribution to disinformation:

In a communication from the European communities to the Council, the European Parliament it is claimed that "soils with an organic substance content of less than 3.6% are in the preliminary stages of desertification" [5]. According to this statement, at least 50% of arable land in Europe is already desert, in Poland it is already 100%. This statement is false and misleading. The television takes over this nonsense with the documentary "Humus, the forgotten climate chance" with the statement: "All of our European farmland is desert"

In these deserts, however, the yields could be tripled in the last few decades.

In the last century, the opinion held: "that one should try to maintain the highest possible level of humus in the soil "[6]. Today the following applies: There is an upper limit for the humus content, exceeding which causes environmental pollution. Excessive humus contents inevitably lead to C and N losses, as also demonstrated by Long-Term Field Experiments (LTE). They show consistently more favorable N balances for mineral fertilizers, which can now be well adapted to the crop requirements in terms of time and quantity.

Long-Term Field Trials as an Indispensable Basis for Humus Research

The variety of influencing factors (texture, climate/weather, management, use, etc.) and their interactions with each other and with the environment requires long-term studies in agricultural and environmental research. While maintaining the ceteris paribus principle, these require LTE and cannot be replaced by anything for methodological reasons. Results make it possible to quantify and interpret the changes that have occurred decades later using modern investigation methods.

In the following, 89 LTE with comparable treatments and resulting characteristics, which represent very different site and management conditions, are evaluated. The difference between the variant that has not been fertilized for many years and the optimally organically and minerally fertilized variants is considered here. This limits the scope that can be used or achieved in practice, regardless of the total salary. The contents of total humus C (processing horizon) are between 0.22% C_{org} and 4.17% C_{org} in 89 LTE (Table 1) [7-9]. In 40 of 89 experiments, the total C_{org} content of the optimally organic and min. fertilized variants was less than 1% C_{org} (= 1.724% humus). This applies for many sandy soils that are optimally supplied, but for which a C_{org} content of 1% is neither sensible nor practically possible.

Table 1: C_{org}-% content in the processing horizon as an average of selected variants of long-term field experiments.

	Europe 42 LTE [7]	India 26 LTE [8]	Russia 21 LTE [9]
1.Without fertilization	0,97 (0,22 - 2,06)	0.54 (0,15 - 1,47)	1,71 (0,50 - 3,93)
2. NPK + org. fertilization	1,29 (0,36 - 2,34)	0,80 (0,24 -2,06)	1,97 (0,79 - 4,17)
3. Diff. between 1 and 2	0,32 (0,09 - 0,88)	0,26 (0,05 - 0,75)	0,26 (0 - 0,48)

It should be noted that the humus content in the soil has always been divided into "permanent humus" (inert, stable) and "nutrient humus" (mineralisable, convertible). This fact usually goes unnoticed. There is no chemical method to determine the permanent humus. However, a perennial bare fallow allows an assessment/calculation of the permanent humus- C. In 1988, Dr. Ines Merbach, Helmholtz Centre for Environmental Research, set up a long-term field experiment with four different fallow variants on the loess site in Bad Lauchstädt.

Figure 1 shows the course of the fallow variants during the first 10 years of the experiment. The bare fallow land is losing about 1000kg C_{org}/ha annually (regression coefficient 0.026), with the green fallow land increasing continuously [10]. After 10 years (Figure 2 shows the results from the 11th to the 35th year of the experiment) the nutrient humus in the bare fallow is already almost exhausted and in the following years there are only very small decreases (regression coefficient 0,002), which amount to about 100kg/ha C_{org} per year. The permanent humus content varies greatly depending on the type of soil and site conditions. According to results from 12 LTE, the C_{org} content is between 0.3 and 1.46% [11].

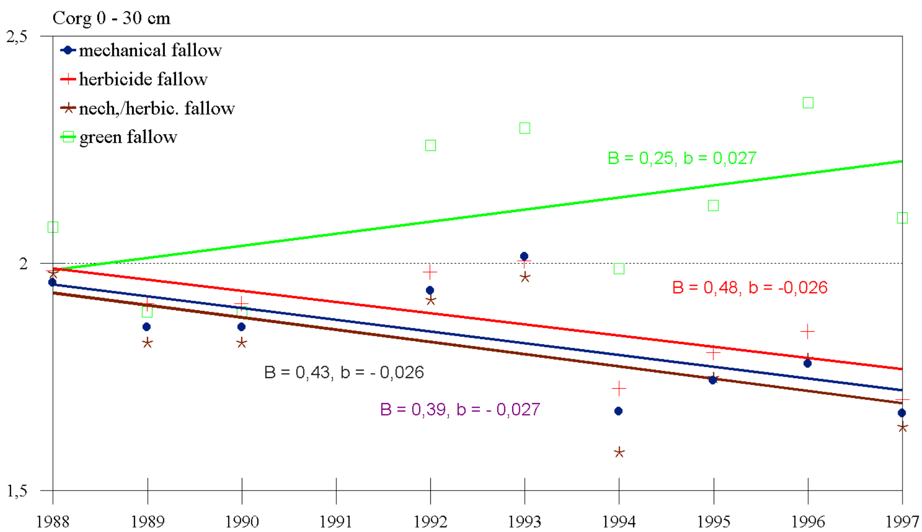


Figure 1: C_{org} content in the Bad Lauchstädt fallow experiment 1988 - 1997 [10].

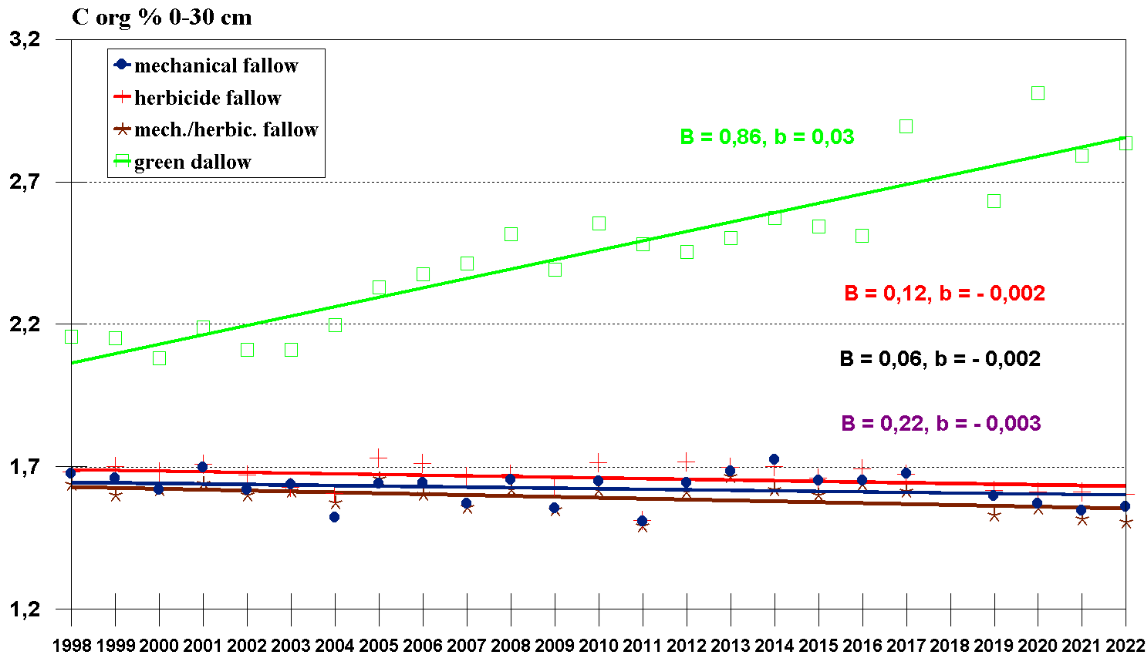


Figure 2: C_{org} content in the Bad Lauchstädt fallow Experiment 1998 - 2022 [10].

Comparison of Yields with and Without Organic Fertilization

In the last century, extensive evaluations of approximately 1100 years of continuous field experiments proved that the soil improving effect of humus, that means the effect, which cannot be achieved with the supply of nutrients alone, brings yield advantages of up to 10% on sandy soil and up to 6% on loamy soil [12]. Yields have increased significantly in recent years, and with the yields, so has the harvest and root residues (HRR) left on the field. A yield increase of 10dt/ha in cereals corresponds to an increase in the HRR of 2dt/ha, and 10cm of stubble length corresponds to straw fertilization of 10dt/ha. The question arises as to whether the humus requirements of the arable land have changed given the current yield level. The results of a total of 350 comparisons revealed a yield advantage of 6% for the combined organo-mineral fertilization compared to the optimal mineral fertilization alone. The lowest effect was recorded for winter wheat with only 3% (n = 92) [7].

This also confirms the previous statements for the yield level of the 21st century. At the same time, it becomes clear that the discussions about an optimal humus content and the humus balance relate to yield differences of less than 6%. A better supply of humus by doing without mineral fertilizers, as they are used in organic farming is not justified. The humus supply of the soil can only be secured via the biomass of the grown plants, with a yield of only 50%, and for winter wheat according to official information 45% (this also applies to the harvest and root residues) certainly not possible, even if the soil supposedly contains more "humus-increasing" plant species. But people eat bread (cereals), potatoes, sugar, vegetables (over 70% of the areas in organic farming are also so-called "humus feeders") and eat less clover-grass, which they consume only in the form of meat and milk, provided that they are not vegans.

Carbon Sequestration

In connection with climate change, the possibility of using the soil as a carbon sink is currently the subject of much discussion. "Carbon sequestration" is neither sensible nor practical. An increase in the C_{org} content in the soil by 0.1% in the cultivation horizon corresponds to 4 to 5t/ha carbon. With an accumulation of 10% and a C content in the plant dry matter of 40%, this requires an effort of 100 - 120dt/ha plant dry matter. The necessary C-input exceeds the possible amount of memory many times over. An increase in the humus content beyond the optimum for the location and management does not bring any advantages either for the yield or for the environment. The 4 per mille initiative is theoretically feasible, only temporarily, if you gave up feeding 8 billion people.

Urgently Needed Research

In the past, humus research took place almost exclusively in the laboratory. The following research problems must be solved for optimum humus management with regard to yield, nutrient utilization and climate impact:

A. Quantification of harvest and root residues under the conditions of yields and harvesting technology of the 21st century, primarily for maize in different cultivation forms.

B. Quantification of the utilization of "Humus-N" compared to "Mineral-N" depending on soil type and yield.

C. Derivation of upper limit values for ecologically justifiable humus contents.

D. Development of practical methods for determining relevant humus fraction.

References

1. Autorenkollektiv (2004) Humus balance - method for assessing and measuring the humus supply of arable land. Point of view of the VDLUFA, Bonn.
2. Müller P (1980) Soil Science, Berlin: German farmer publisher, p. 392
3. Raggam A (2008) Biomass stops climate change, dvb-verlag, (2nd edn).
4. Scheub U, Schwarzer S (2018) Die Humusrevolution./IIIoekom. 240.
5. Autorenkollektiv (2002) Brussels: Communication from the Commission to the Council, the European Parliament, the Economic and Social Committee and the Committee of the Regions.
6. Sauerbeck D (1992) Functions and importance of organic substances for soil fertility - an overview. In: Soil use and soil fertility, Volume 4, Humus budget, Verlag Paul Parey, p.13-29
7. Körschens M (2021) Long-Term Field Experiments (LTEs)-importance, overview, soil organic matter. In: Mueller L, Sychev VG, Dronin NM, Eulenstein F (Eds.), Exploring and Optimizing Agricultural Landscapes. Innovations in Landscape Research. Springer, pp: 215 -231.
8. Pathak H, Byjesh K, Charkrabart IB, Aggarwa LPK (2011) Potential and cost of carbon sequestration in Indian agriculture: Estimates from long-term field experiments. Field Crop Res 120(1): 102-111.
9. Sychev VG, Naliukhin AN, Shevtsova LK, Rukhovich OV, Belichenko MV (2020) Influence of fertilizer systems on soil organic carbon content and crop yield: Results of long-term field experiments at the geographical network of research stations in Russia. Eurasian Soil Science 53(12): 1794-1808.
10. Merbach I (2023) Helmholtz Center for Environmental Research - UFZ - Test Station Bad Lauchstädt.
11. Körschens M (2021) Long-term field experiments as the basis for practice-oriented humus research - a review. Mod Concep Dev Agrono 9(3):
12. Scholz S (1978) Relationship between SOM content and yield derived from endurance tests. Synthetic information, Research Center for Soil Fertility Müncheberg, Bad Lauchstädt Area.